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AUTHOR Goldberg, Julie L.; Sedlacek, William E.
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ABSTRACT

This paper summarizes the initiatives taken by the Women in Engineering Program at the A. James Clark School of Engineering at the University of Maryland. Two programs are described - the Research Fellows Program and the Teaching Fellows Program. Both are designed to expose women undergraduate students in engineering to the challenges and rewards of engineering careers in academia. The paper examines the structure and implementation of both programs. The research program outline includes a description of the application and selection process; orientation; research activities; students' experiences of working with faculty and graduate students; "Research Forum Celebration"; and focus groups. Overall, the fellows reported that their confidence in their skills and interest in engineering had increased. A total of 90 percent of the students agreed that their experience as a fellow had helped them. The Teaching Fellows Program was designed to provide undergraduate female engineering students an opportunity to assist a faculty member in teaching a lower level engineering course. The fellows participated in a wide range of teaching activities, such as presenting lectures, grading homework, holding office hours, referring students to other university resources, facilitating small group discussions, and tutoring and mentoring students. This program can help mitigate the lack of female role models in the engineering classroom. (CK)

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Research Report #15-95

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Counseling Center
University of Maryland at College Park
College Park, Maryland

**Teaching and Research Fellowship Programs:
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Summary

This paper presents a summary of the initiatives taken by the Women in Engineering Program at the A. James Clark School of Engineering at the University of Maryland at College Park. Two programs funded by the Alfred P. Sloan Foundation are described - the Teaching Fellows Program and the Research Fellows Program. Both programs are designed to expose women undergraduate students in engineering to the challenges and rewards of engineering careers in academia. The paper examines the structure and implementation of both programs.

¹ This paper was presented at the "Women in Engineering Program Advocates Network" national conference in Washington DC in June 1995.

Teaching and Research Fellowship Programs:

Encouraging Undergraduate Women to Explore Careers in Academia

Women's participation in the United States workforce has increased dramatically over the past twenty years (National Science Foundation, 1994). Nevertheless, women still remain underrepresented in the fields of science and engineering. After tracing the employment trends of female engineers and scientists, it is apparent that "despite two decades of women swelling the ranks of doctoral scientists and engineers, the percentage of tenured faculty members who are women barely increased between 1983 and 1989: moving from just 9 percent to just below 12 percent" (Barber, 1995). However, by adding the percentages of female scientists and engineers together, the absence of female engineers is hidden. In 1989, 2.7% of all the doctoral level engineers employed in higher educational 4-year institutions were women: .7% of the professors, 3% of the associate professors, and 7% of the assistant professors were women (National Science Foundation, 1992).

The absence of female faculty in engineering can be directly linked to the small number of women in engineering graduate programs; in 1993, 16% of the masters degrees and 11% of the doctoral degrees in engineering were awarded to women (Engineering Workforce Commission, 1994). In order to increase the number of women in graduate programs and therefore the pool of potential candidates for faculty positions, efforts must be made to ensure that a higher percentage of undergraduate women have the resources to pursue a graduate education. Therefore, strategies to address the lack of female faculty in engineering need to be initiated at the undergraduate level by providing female students with an opportunity to develop the skills and confidence to succeed at the graduate level.

To create such opportunities, the Women in Engineering (WIE) Program at the A. James Clark School of Engineering at the University of Maryland, College Park, implemented the Research and Teaching Fellows Programs in the Fall of 1994. Supported by a grant from the Alfred P. Sloan Foundation, female undergraduate engineering students assisted faculty in developing meaningful research projects and in teaching undergraduate lower level engineering courses. The programs were designed to develop the students' skills and to provide opportunities to explore college teaching and research as a potential career path. In order to further illustrate the purpose, goals, and design of each program, a description is provided below.

The Research Fellows Program

Success in engineering graduate studies requires students to become actively involved in conducting research. However, undergraduate students rarely have the opportunity to become involved in research projects and as a result, students may question their interest in and ability to engage in research. In order to provide undergraduate female students with an opportunity to gain hands-on research experience, the first Research Fellows Program was implemented in September 1994. During the Fall 1994 and Spring 1995 semester, the Program awarded a total of 24 research fellowships. All of the Fellows were awarded a honorarium of \$500.00 each semester.

An outline of the Research Fellows Program is provided below and includes a description of the following: application and selection process, orientation, research activities, students' experiences of working with faculty and graduate students, "Research Forum Celebration," and focus groups. Finally, the evaluation of the Research Fellows Program is presented.

Application and Selection Process

To be considered for a Research Fellowship, each student was required to find a faculty member with whom to work. Students were encouraged to join an on-going research project spearheaded by the faculty member or to create a new project with the faculty member. When a student was unsure of which faculty member to approach, the WIE Program provided the student with names of possible professors. All female students enrolled in engineering courses were invited to apply for the fellowship.

Once "matched" with a faculty member, the student submitted an application which included the student's transcript and a research proposal. The proposal provided a description of the project as well as an outline of the roles and responsibilities of the Fellow (i.e., the number of hours she would work each week, how she would be supervised, the goals the Fellow would meet by the end of the semester, and how the Fellow would meet these goals). Finally, the faculty member and student were required to establish the faculty supervisor's responsibilities (i.e., how frequently the team would meet, how the Fellow's work would be evaluated, and how the faculty member would mentor the Fellow).

One of the most important aspects of the application process was that it specifically required the faculty and student to define how the faculty member planned to mentor the Fellow. For many faculty and students who have never reflected upon the meaning and role of a mentor, this provided an excellent opportunity for both to articulate the multiple ways the faculty member could help cultivate the student's professional development. Students were awarded a Fellowship based on whether the defined proposal goals fit the overall goals of the Research Fellows Program.

Orientation

During the November 1994 focus group, Fellows suggested that an orientation be added to the program. As a result, in the first week of the Spring 1995 semester, an orientation was held to introduce the Fellows to one another, to review the research Fellowship requirements (attending two focus groups and the "Research Forum Celebration"), and to complete payroll forms. In addition, in order to familiarize the Fellows to the evaluation process, a brief introduction to the purpose and function of focus groups was provided.

Becoming Involved in Research

The 1994-95 Fellows were introduced to the various steps involved in the research process. The Spring 1995 Fellows reported that they had accomplished the following: 10% worked on a grant to secure funding for a project, 50% designed experiments, 70% ran experiments, 40% completed a literature review for a project, 30% wrote a paper on a research project, and 20% presented research at a conference or symposium. The Fall 1994 Fellows reported similar experiences. In addition, the Fellows completed other tasks including performing volume calculations, presenting research for a company funding the project, producing drawings for publication on CAD software, and completing data analysis (Goldberg & Morris, 1995).

Working With Faculty and Graduate Students

During the semester, the Fellows met regularly (i.e., weekly) with their assigned faculty member. Through this experience, many of the students were able to develop mentoring relationships with faculty members. In addition, 40% of the Fall 1994 Fellows and 65% of the Spring 1995 Fellows reported that they worked directly with a graduate student (Goldberg & Morris, 1995). This contact helped the Fellows to understand some of the roles and

responsibilities of graduate school and to conduct research at the graduate school level. For many, the graduate students became their role models and mentors.

Research Forum Celebration

In order to provide students with an opportunity to gain experience in presenting research, the WIE Program sponsored a "Research Forum Celebration" for the Fellows at the end of the Spring 1995 semester. The supervising faculty and graduate students, the Deans of the School of Engineering, and the Department Chairs were invited to attend the ceremony. Students were encouraged to invite guests, including family members. During the celebration, each Fellow had an opportunity to briefly introduce herself and explain her research topic. In addition, seven Fellows gave 5-7 minute presentations on their research projects. In order to honor their hard work and dedication, certificates were awarded to all of the Fellows.

Focus Groups

All of the students participated in two ninety-minute focus groups during each semester they were a Fellow. The primary purpose of the focus groups was to gather valuable feedback from the students so that the staff would be able to change the program to better fit the students' needs. In addition, the focus groups became a forum for female engineering students from several different disciplines to meet. Within this realm, they exchanged thoughts about their experiences and provided suggestions for one another on how to communicate with their assigned faculty, locate resources, and manage their research and school assignments.

Evaluation

In order to assess the quality and effectiveness of the program, both qualitative and quantitative methods of evaluation were employed; surveys were conducted at the beginning of each focus group. According to the student participants, the first year of the WIE Research

Fellowship Program was successful. When asked to rate the overall program, 95% of the students and 100% of the faculty members reported that it was good to excellent. In March 1995, all (100%) of the students reported that they had already or were planning to recommend the program to another student (Goldberg & Morris, 1995).

Benefits and Outcomes

The Research Fellows Program plays an important role in dismantling the barriers that impede women in engineering from pursuing graduate studies. During the focus group, for example, several students discussed the importance of establishing mentoring relationship with faculty members. Similar to the beneficial outcomes cited in the literature, many of the Fellows reported that their mentor often provided individual encouragement as well as valuable information about the formal and informal rules for their professional development (i.e., courses to take and networks for job searching) (Brainard & Alies-Sengers, 1994). During the focus group discussions many of the Fellows also spoke about the positive impact that such recognition had on their experience as students.

Overall, the Fellows reported that their confidence in their skills and interest in engineering had increased. In the March 1995 survey, 90% of the students agreed or strongly agreed that their experience as a Fellow had helped them to feel more confident in their ability to be an engineer while 85% agreed or strongly agreed that their interest in engineering had increased. The Fellows' increased interest in engineering was associated with a subsequent increased interest in applying to graduate school; when the Fellows were asked whether they were considering applying to graduate school before they began their Fellowship, 70% stated that they had. Thirty percent reported that they had not. Of the 70% who stated that they had considered applying, 71% reported that their experience as a Fellow had reinforced their

decision. In addition, of the 30% that reported that they had not considered applying to graduate school prior to the program, 67% reported that their experience had been encouraging enough that they were now interested in applying to graduate school. One student explained in the written section of the survey, "I really had not thought about graduate school until I started research. Now I see what it is all about and how important it is" (Goldberg & Morris, 1995).

The Teaching Fellows Program

With such few female engineering faculty, undergraduate women students rarely take engineering classes that are taught by women. In order to encourage women students to consider becoming engineering faculty members themselves, the WIE Teaching Fellowship Program was implemented in the Fall of 1994. The Program was designed to provide undergraduate female engineering students an opportunity to assist a faculty member in teaching a lower level engineering course. Through this experience, the Fellows participate in a wide range of teaching activities such as: presenting lectures, grading homework, holding office hours, referring students to other university resources (i.e., academic advising, study skills and time management, general tutoring and personal counseling), facilitating small group discussions, and tutoring and mentoring students. All of the Fellows were awarded a honorarium of \$500.00 each semester.

The WIE Teaching Fellows Program has three components including the ECSEL (Engineering Coalition of Schools for Excellence in Education and Leadership) Teaching Fellows Program, the Summer Engineering Programs for High School Women, and the Engineering Curriculum Transformation Project. Each endeavor is described below.

The ECSEL Teaching Fellows Program

During the 1994-95 academic year, four WIE Teaching Fellows assisted faculty in the freshman engineering design course through the ECSEL Teaching Fellows Program. Now in its

third year, the ECSEL Teaching Fellows Program has been successful in placing senior engineering students in the classroom to assist the faculty in teaching the required introductory course to engineering design (ENES 100). The Program was originally established to help new engineering students develop a connection to the School of Engineering. In essence, the Fellows interact with new students both inside and outside of the classroom by teaching information, providing referrals for assistance, mentoring, and tutoring (Fines, Regan, & Johnson, 1995). Also, the Fellows encourage new students to become involved in student organizations and activities. Thus, the program provides opportunities for senior engineering students to develop their communication and leadership skills as well as to explore college teaching as a potential career option.

Students were selected using both an application and interview process. Fellowships were awarded on the basis of the student's leadership abilities, academic records, and interest in teaching. During the semester, the Fellows participated in a one credit hour course ("Seminar in College Teaching") offered by the School of Engineering Student Affairs Office. This serves as both training and supervision in that the Fellows "report on the status of their particular section of ENES 100 and discuss problems that may be occurring in class and how to solve them" (Fines et al., 1995). In addition, Fellows are introduced to student development theory, classroom climate issues, and teaching techniques.

Evaluation of the program includes both focus group method and surveys. In a summarizing the results of the focus group discussions, Fines and associates (1995) explain that "many of the Fellows were interested in the possibility of teaching before becoming a Fellow. The students indicated that they have enjoyed their teaching experience, and are considering graduate school as a result of their teaching fellow experience. They have realized what goes

into teaching and have gained the confidence and skills for teaching in subject areas that interest them.

Summer Engineering Programs For High School Women

Each summer the WIE Program offers two engineering programs to high school women interested in engineering: a six-week academic program for high school women who have completed 11th grade and a one-week summer program for 10th through 12th graders. Both programs are designed to teach students introductory engineering principles through an experiential learning process. Fundamental concepts are conveyed through hands-on design projects, field trips, and laboratory work. Four Teaching Fellows have been selected for the 1995 Summer Programs.

During the six-week academic program, the high school students complete two first year introductory engineering courses. Throughout the summer, the Fellows work directly with the high school students by attending class with them, answering questions during labs, and providing one-on-one tutoring. In addition, two of the Fellows also assist with instructing the labs and lectures offered during the one-week summer program. Thus, the Fellows have the opportunity to cultivate the younger generation of female engineers in addition to enhancing their teaching skills.

Engineering Curriculum Transformation Project

In the Fall 1995 semester, eight faculty members and eight Teaching Fellows will take part in the first Engineering Curriculum Transformation Project. Through a seminar style approach, faculty will reconstruct a course curriculum based on diverse learning styles, more inclusive examples, and incorporation of diversity and societal issues. During the seminars, faculty will discuss issues of women, race, and class in science and engineering, whether

science and technology are biased or gendered, the culture of engineering, paradigms for change in engineering and technology courses (i.e., resources, sample syllabi), and techniques to ensure an inclusive classroom and an inviting syllabus. Each faculty will be assisted by a Teaching Fellow.

At the end of the Fall 1995 semester, the faculty and Teaching Fellow will produce a fully revised course curriculum. During the following Spring 1996 semester, the Teaching Fellows will aid the faculty members in the instruction of this revised course. In addition, the faculty members will participate in evaluating and critiquing each other, and as a group, will produce guidelines and recommendations for other engineering faculty members to revise their course curriculum. In subsequent years, the newly revised courses will include Women in Engineering Teaching Fellows.

Benefits and Outcomes

The Teaching Fellows Program plays an important role in mitigating the void of female role models in engineering classroom. By placing the Teaching Fellows in the classroom, undergraduate female engineering students have the opportunity to envision themselves as a faculty members. In addition, the Fellows provide a role model for other female engineering students. In essence, the Teaching Fellows Program plays a critical role in changing the "chilly climate" embedded in the culture of engineering education.

Conclusion

Students rarely have an opportunity to engage in research and teaching during their undergraduate education. By providing the programs described above, undergraduate female

engineering students are able to gain the necessary resources to pursue a graduate degree in engineering. Through the program, women student gain confidence in their research and teaching skills as well as gain the credentials to be competitive candidates for graduate programs and financial funding. From their experience, students also have an opportunity to explore college teaching and research as potential career options. Such opportunities encourage young female engineering students to pursue career paths in academia and therefore, serve to increase the number of females in advanced engineering programs and faculty tenure positions. In conclusion, the Research and Teaching Fellows Programs play an instrumental role in pushing forward the frontiers of modern day engineering education.

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